THE

AGRICULTURAL BULLETIN

OF THE

FEDERATED MALAY STATES.

No. 3.] DECEMBER, 1917. [Vol. VI.

RESULTS OF RECENT VULCANIZATION RESEARCHES AT THE AGRICULTURAL DEPARTMENT, FEDERATED MALAY STATES.

By B. J. Eaton.

IN view of the fact that many of the most recent results in rubber research obtained in the chemical laboratory and experimental vulcanizing factory of the Department of Agriculture, have been given at various lectures before Planters' Associations in various districts during the year, without having been published subsequently, it is considered desirable to summarize these from time to time. These results have also been presented at the end of every quarter to the Advisory Committee of the Agricultural Department and have recently been forwarded to the Ceylon Government, since the departure of the Rubber Research Chemist from that Colony to join the Imperial Forces.

It is not intended to give minute details and figures in the case of all the experiments carried out, since the methods of vulcanization adopted and the general technique of the work has already been published. As in the case of most of the previous work, each experiment to determine the effect of any particular factor on the variability of rubber has been repeated usually ten times, in order to eliminate any secondary factors.

The present report contains the results obtained during the first three quarters of the present year. (*Note.*—A summary of the researches for 1916 is contained in the Annual Report of the Director of Agriculture for 1916.)

Effect of Rolling Up Wet Sheet and Slab of Varying Thickness.

It has been shown previously by the writer, that if sheet of average thickness is rolled up wet—*i.e.*, rolled into a cylinder direct from the sheeting machine, and left rolled up in this form for about 6-7 days, it develops nearly the same rapidity of vulcanization as "slab" rubber.

Experiments on similar lines, with thin slabs and thick and thin sheets show that, except in the case of very thin sheet, the rate of cure can be brought to a definite maximum and is as rapid as that of

slab. Even with thin sheet, the cure is very greatly accelerated and both with thin and thick sheet, the rate of cure is nearly as rapid as in the case of slab, which proves that the moisture content (as distinct from the effect of serum) is the determining factor, since in the preparation of thin sheet, most of the serum has been rolled or squeezed out. The influence of the serum, *per se*, apart from its effect due to the water content, as shown in the greater rapidity of cure of slab and thin rolled up wet slab, is due undoubtedly to the second accelerating factor which the writer has shown to be present in Hevea latex and serum and which exists preformed in the latex.

Effect of Soaking "Slab" Rubber in Water.

Further experiments on soaking fresh coagulum in water, show that running water has a much greater effect in retarding rate of vulcanization than stagnant water; this is due no doubt principally to the leaching out of the accelerator present in the latex and serum and also to the different conditions brought about, which prevent to some extent the formation of the accelerating agent produced by the degradation of the proteins, or even to a leaching out of this substance after its formation.

Even when the coagulum is allowed to mature, after removal from the water, it does not attain to the rapidity of cure of ordinary "slab" rubber.

Effect of Various Antiseptic Substances.

Experiments made by soaking fresh coagulum in dilute solution of ammonia, boracic acid and tannic acid show that these substances have a marked effect in retarding rate of vulcanization. The carbonates of both potassium and sodium, like the hydroxides, markedly accelerate rate of vulcanization.

Tartaric Acid as a Coagulant.

It has been shown previously by the writer that the weak organic acid such as acetic, formic and citric acids when used as coagulants are very similar, in their effect on rate of vulcanization. Tartaric acid, which was not available at the time, has since been examined, and, as anticipated, is very similar to the other weak organic acids. All of these acids are therefore suitable coagulants, but, with the exception of acetic and formic acids, are not economical, on account of their cost.

The Smoking Problem and Drying by Hot Air.

Our early results, which showed that smoking retarded vulcanization, have been criticized adversely by certain workers on the problem, although more recent work carried out at the Imperial Institute, London, on behalf of the Ceylon Government, not only confirmed our results, but led to the conclusion, that smoking had a very marked effect in retarding vulcanization. Later work by the writer showed that in some cases smoked sheet cured slightly faster than unsmoked sheet, prepared otherwise under similar conditions.

As was suggested by the writer in previous work, in the smoking of rubber two factors are concerned—*viz.*, the temperature and the smoke products.

The writer in 1915, in experiments which have not yet been published, found that the soaking of "slab" rubber in phenol,

retarded vulcanization. Whitby independently in 1916 obtained similar results (*Vide Jour. Soc. of Chem. Industry*, Vol. XXXV, No. 9, May 15 to 16.) The writer and Whitby together published a paper in this bulletin (*Agricultural Bulletin, F.M.S.*, Vol. V, No. 4, January, 1917), showing the retardation in rate of vulcanization caused by phenols, and also by crude pyroligneous acids which contain phenolic substances.

Experiments were therefore necessary with a view to the isolation of the two factors present in the ordinary smoking of rubber in a smoke house. This has been done by drying slab and sheet rubber in hot air chambers at the temperature usually employed in smoke houses—*viz.*, about 120° Fah. These experiments have shown definitely that hot air drying of sheet at this temperature accelerates the rate of cure. Similarly experiments with "slab" rubber, in which smoking has been found invariably to retard the rate of vulcanization, have shown that hot air drying at about 120° Fah. has a very marked effect in accelerating rate of vulcanization. By leaving slabs in a hot air chamber for six days [the usual maturation period necessary at ordinary shade temperature (85°Fah.) to obtain maximum rate of vulcanization], vulcanization can be effected under the conditions employed at the Agricultural Department laboratry in $\frac{1}{2}$ to $\frac{3}{4}$ hour, compared with about $1\frac{1}{4}$ hours in the case of slab rubber dried at ordinary temperature. (*Note.*—In the case of slab coagulated with minimum amount of acetic acid, from latex diluted to contain 1.5 lbs. of dry rubber per gallon of latex.) The same rate of cure (*viz.*, $1\frac{1}{4}$ hours) is obtained by a maturation period of three days at 120°Fah., as in six days at ordinary shade temperature (85°Fah.). Another interesting feature of maturing in a hot air chamber, is that the moisture content of the slab, can be reduced to about 15 per cent. during six days.

Experiments carried out for the writer by the manager of an estate, in which slab rubber was heated in a Colombo hot air drier at about 160°Fah. for periods of 2 to 8 days, showed that this higher temperature retards vulcanization; such a temperature is obviously above the optimum for the biological changes which take place. It is therefore possible in some instances, especially in the case of smoked sheet, that both the temperature factor and the smoke products may retard rate of vulcanization. The optimum temperature would appear to be about 120°-130°Fah., but further experiments are required with regard to the actual optimum temperature.

These experiments prove definitely that the balance of these two factors—*i.e.*, temperature and smoke, during the first few days of drying or smoking of the raw rubber, determines the rate of vulcanization. It is also obvious from these results, that the type of fuel may have a decided influence—*e.g.*, fuel which gives a large quantity of creosotic vapours is undesirable.

In view also of the fact that by preparing slab rubber from concentrated latex (*vide* later experiments described here) a more rapidly vulcanizing rubber can be obtained, it is possible that, by hot air drying (incubating) slab rubber from concentrated latex, a rubber can be obtained which will cure in about $\frac{1}{4}$-$\frac{1}{2}$ hour, under the conditions of vulcanization employed. Experiments on this point are being carried out.

The importance of these results in connection with the preparation of a very rapidly curing slab rubber are obvious. From the practical or estate point of view, the ordinary smoke house could be adapted to the purpose. It would only be necessary to erect a type of furnace in the smoke house, with arrangements to allow the smoke to escape, while retaining all the heat. Other obvious methods of keeping a constant temperature in such rooms, could also be adopted.

Very recent experiments on the smoking of matured slab cut into worms after maturing and other samples crêped after maturing and subsequently smoked, have shown that not only does the smoking process retard the rate of vulcanization of slab in virtue of its antiseptic properties if employed during the maturation period, but that the smoking subsequent to maturation causes a marked retardation in rate of cure, especially in the case of slab which is crêped and smoked. It is obvious from the results of these experiments that certain of the smoke products, therefore, either destroy the accelerator formed during the maturation period or that the smoke products act as retarding agents and neutralize any accelerating effect of the accelerator formed during maturation. The effect is very definite but less marked in the case of the slab cut up into worms and smoked than in the case of the crêped slab—probably due to the much greater absorption of these products by the crêped slab, owing to the large amount of surface exposed.

Probable Final Method of Preparation of "Slab" Rubber.

Before leaving this subject, reference might be made to the best method of preparation of this type of rubber, which would obviate the necessity of shipping virgin slab, containing 15-20 per cent. of moisture and also the necessity of heavy machinery to convert such rubber into crêpe in the estate factory, in order to ship dry rubber. The method suggested is, after maturation, to cut up the slab into worms, which are then vacuum or hot air dried (a period of one day should be sufficient for the complete drying of the worms) and pressed by hydraulic pressure into dry blocks about 1-2 inches thick or other suitable thickness. A machine with rapidly revolving knives on cylinders would be suitable for this purpose. The power required to drive such machines would be very small, compared with the power required to convert the partially dried rubber into crêpe. Further, large drying rooms would be unnecessary and the rubber could be ready for packing in 8 to 9 days after coagulation and the packing space would be reduced considerably.

Soaking of Sheet in Water.

A defect in the appearance of smoked sheet known on the market as "rust" has been shown previously to be due to the exudation of the serum in the sheet, which collects on the surface during drying and contraction and forms a thin invisible film until the dry sheet is stretched or scratched, when, it presents a brownish powdery appearance.

In order to obviate this defect, it is a common practice on some estates to soak the freshly machined sheet in cold or tepid water, for an hour or two after machining, before hanging in the smoke house, so that much of the serum is taken up by the bath of water.

In order to ascertain whether this practice had any effect on the sheet rubber, samples were soaked overnight before being hung to dry or smoke. Samples of smoked and unsmoked sheets treated in this manner, together with controls were prepared and vulcanized. In no case was any effect produced, so that the practice can be recommended for the purpose in view.

Tank *v.* Pan Sheet.

From the point of view of uniformity in estate practice, it was considered advisable to ascertain whether any differences existed between tank and pan sheets. As is well-known here, but probably not known elsewhere, the majority of tanks have divisions at intervals of about $1\frac{1}{2}$ inches, whereas the ordinary gallon pan, in which a gallon of latex is usually placed, is about $3\frac{1}{2}$ inches deep—*i.e.*, the fresh coagulum in the former is about $1\frac{1}{2}$ inches thick and in the latter about $3\frac{1}{2}$ inches thick.

As would be expected, when these coagula are rolled to sheet, and the distance between the rollers is the same in each case, the thinner coagulum from the tanks, spreads to a greater extent, laterally and longitudinally and consequently produces a thinner sheet than the thicker coagulum from the pan. The final rolled sheet from the thinner coagulum is also softer and more porous and consequently dries more rapidly. Hence, as would be expected, such tank sheet vulcanizes more slowly than pan sheet, owing to its more rapid rate of drying and consequent less biological change of the proteins. On the other hand, if tank sheet is rolled to the same thickness, as pan sheet, requiring rollers which are not tightened to so great an extent, the former vulcanizes more rapidly than the latter, although owing to its softness and porosity it dries as rapidly or more rapidly than the pan sheet. This again is what would be expected, since in this case, the tank sheet retains proportionately more serum and therefore more of the accelerating agent present in such serum, while at the same time, more of the accelerating agent derived from the degradation of the proteins is produced.

The practical advantages are therefore in favour of tank sheet, since to obtain the same vulcanizing capacity with an equally rapid rate of drying, it is not necessary to roll tank sheet to as great an extent as pan sheet. The results also illustrate another factor in estate factory practice causing variability—*viz.*, coagulation of different depths of latex in the ordinary coagulating pans. On some estates, only half a gallon of latex is placed in a pan and in others a gallon.

In the conversion of these coagula into thin crêpe, the differences would be negligible. If the two coagula are left in slab form, it has been found that slab of $1\frac{1}{2}$ inch thickness is about the minimum to allow the maximum biological changes to take place. Thinner slab dries too rapidly, to permit of the maximum rate of vulcanization.

Other previous experiments by the writer on this point, in which very thin layers of latex, coagulated in the ordinary way with acetic acid, were compared with 3 inch thick slab prepared otherwise in a similar manner, have confirmed these results. In the thin layers, vulcanization is retarded considerably, on account of the

fact that such thin layers dry too rapidly for any marked biological changes to take place. At the same time these thin layers cure more rapidly than sheet of average thickness on account of the fact that they contain proportionately more serum, even after being lightly hand-rolled.

Blocked and Rolled Up Thin Wet Crêpe and the Development of Chromogenic Organisms.

It has been shown previously by the writer (*Agricultural Bulletin, F.M.S.*, Vol. V, Nos. 5 and 6, February and March, 1917,) that chromogenic organisms, responsible for "spot" disease of rubber, develop in dry crêpe rubber which has been dipped into water and then rolled into cylinders by hand, and also to a greater extent in freshly machined thin wet crêpe rolled up in a similar manner. (This latter has been shown previously by Bancroft, Sharples and others—*Vide Bulletins* Nos. 16 and 19, Agricultural Department, F.M.S.) On the other hand, no such development takes place in slab rubber nor in rolled up wet sheet.

Recent experiments in which thin wet crêpe was converted into block by hydraulic pressure have shown that these organisms do not develop in the block, when the block is sufficiently solid and non-porous, although, if the pressure is insufficient to produce a solid block, pigment is formed, which shows the development of these organisms.

The writer has also proved recently that rolled up thin wet crêpe, in which "spot" disease is always very pronounced, does not develop a rapid rate of vulcanization like similarly rolled up sheet.

On the other hand, blocked wet thin crêpe, in which no "spot" disease develops, has its rate of cure accelerated to a considerable extent. Similarly, blanketed thin wet crêpe, has a greater rate of cure than the thin crêpe from which it is prepared. Blocked wet crêpe is essentially very thick blanket crêpe.

These results indicated a close connection between the non accelerating effect produced by rolling up thin wet crêpe contrasted with the acceleration produced in similar blocked thin wet crêpe and the development of "spot" disease.

The final proof of the effect of "spot" disease was made, by rolling up wet "slab" crêpe—*i.e.*, slab allowed to mature for six days, converted to thin crêpe and then immediately rolled up into a cylinder.

In this case a marked development of "spot" disease also occurred and the vulcanization of the rubber was considerably retarded.

In some experiments the rolls were merely unrolled and hung to dry, while in others they were rewashed and recrêped. In both cases however the retardation results were similar, which showed that the change was produced in the rubber and was not due to a subsequent washing out of any accelerating constituent.

It is obvious therefore that these chromogenic organisms utilize, destroy or change the vulcanization accelerator formed by the degradation of the protein by other organisms, so that it no longer behaves as an accelerator. The fact that these chromogenic

organisms do not appreciably alter the vulcanizing capacity of ordinary slow curing crêpe can be explained on the ground that such crêpe contains little or none of these accelerating substances and the organisms utilize the protein itself, which already exists in more than sufficient quantity in crêpe for normal vulcanization.

Whether the protein in ordinary thin crêpe is actually decreased by these organisms has not yet been ascertained.

This is, as far as the writer is aware, the first occasion on which any detrimental effect has been attributed to these chromogenic organisms.

Further Experiments on Excessive Crêping.

The first experiments on the effect of excessive crêping were carried out at an early stage of these researches and showed that the principal effect was a retardation of vulcanization. Recent experiments have confirmed these and have shown, as the writer has stated, on many previous occasions, that the final thickness of the crêpe chiefly determines its rate of cure. That is to say, minimum crêpeing to a certain thickness, followed by passing such crêpe twice through a sheeting machine which makes it slightly thinner and produces an even smooth surface, causes the rubber to cure as slowly as the thicker crêpe obtained on the crêpeing machine which has been passed many more times between the crêpeing rolls, without the final treatment on the smooth sheeting rolls. Two factors are concerned, as has been stated before—*viz.*, the thinning of the crêpe causing rapidity of drying and hence reduction of any biological change and the washing out of serum products which also act as accelerators of vulcanization.

Effect of Concentration of Latex.

Experiments were carried out about two years ago on the effect of concentration of latex on rate of vulcanization, which showed, as was anticipated that the more concentrated the latex, the greater the rapidity of cure, in the case of slab, sheet and crêpe.

In these earlier experiments, however, the most concentrated latices employed contained only about 2 lbs. of dry rubber per gallon.

These experiments have therefore been repeated with latex containing 3 lbs. and over of dry rubber per gallon, compared with latex containing 1.5 lbs. per gallon.

In these more recent experiments, the effect of concentration of the latex is even more marked, as would be expected and the results entirely confirm those of the earlier experiments.

As applied to the preparation of a rapidly vulcanizing rubber, it is probable that by incubating coagulum from concentrated latex at about 120° Fah., a rubber curing at about $\frac{1}{4}$ to $\frac{1}{2}$ hour under the conditions of vulcanization employed in our laboratory can be prepared.

Summary.

The results of the recent researches described above, confirm entirely the previous work carried out in this laboratory and add a number of interesting and important facts to the problem of variability of Para rubber and its cause.

FURTHER NOTES ON BLACK-STRIPE CANKER.

By W. N. C. Belgrave.

IN "Notes on Bark Cankers," written in July, it was recommended that except for slight attacks, all tissues affected by "black-stripe" should be excised. Pratt, presumably dealing with conditions obtaining in Sumatra, criticized this in the *Malayan Tin and Rubber Journal*, September 28th, 1917, on the ground that it was harmful and unnecessary, as attacked trees healed without any treatment.

Further experience in Malaya bears out the latter part of his statement for the majority, perhaps even the great majority, of cases. If the attack be detected, and tapping stopped early enough, the progress of the fungus is arrested, and, although wood penetration has taken place, a layer of healthy wood is laid down over the diseased patch which seems effectively to prevent the fungus reappearing. Although this takes place without treatment, it is safer to paint diseased patches with dilute brunolinum, or some similar paint to prevent formation of surface mycelium and possible spread of the disease.

While this happens in the great majority of cases, it is, at any rate in Malaya, not the invariable course of the disease. There are a certain number of attacks which seem to be much more virulent. Sheets of diseased tissue, instead of stripes, are formed, and the fungus rapidly runs down past the tapping cut, sometimes for more than a foot into the untapped bark. Over such areas, the whole of the cambium is killed, and renewal if it comes at all must come from the sides. In such cases, both from the point of view of arresting spread, and renewal, excision of the diseased bark and possibly wood appears to be called for. Tar and jodelite, or solignum should be applied to the exposed surfaces.

These bad cases are sometimes the result of neglect—*i.e.*, of continuation of tapping but are often virulent from the start. It is a curious fact that one of the first epidemics investigated consisted almost entirely of such virulent cases. Latterly only isolated instances have been found.

In the same article Pratt contradicts the statement that the susceptible area extends $1\frac{1}{2}$ to 2 inches above the tapping cut, stating that it is about 1/8 of this. Whatever the area most usually attacked may be, it is easily demonstrable (by putting some of the fungus above $1\frac{1}{2}$ inches above the tapping cut, and keeping the spot moist for a few hours) that the susceptible area does extend the distance stated by us.

Sterilization of Tapping Knives.

It was stated in "Notes on Bark Cankers" that some doubt existed as to the necessity of sterilizing tapping knives in addition to preventive painting; because of the possibility of the fungus spores being carried to the tree on the knife, and protected from the paint by the coagulated scrap.

Thirty-six trees in two rows were taken and marked successively A, B, and C, thus:

A	B	C		A	B	C	.	.
B	C	A		B	C	A	.	.

The trees were tapped with a knife which between each tree, was dipped into a suspension of zoospores of the *Phytophthora* sp. isolated from "black-stripe." When the latex was collected trees marked "A" were painted with "formalin-bisulphite," and these marked "B" with 5 per cent. izal, "C" trees were left as controls.

After three days the cuts were carefully examined with the following results:

Mark	A (Formalin-bisulphite)	B (Izal)	C (Control)
No. of trees with "black-stripe"...	1	1	9
Total number ...	12	12	12

i.e., for all practical purposes painting, without sterilization of knives, may be taken as sufficient.

Later, it was pointed out to me that mere dipping of the knife into 5 per cent. formalin, or other disinfectant was insufficient to sterilize it. To test this—a tapping knife was drawn on the surface of an agar culture of *Phytophora* sp., and also over a culture of the organism believed to cause "brown bast." It was dipped into 5 per cent. formalin, and then drawn over fresh agar in sterilized tubes. Later *Phytophora* developed in one of three tubes, and the "brown bast" (?) organism in all three—*i.e.*, sterilization had not been effected.

Choice of Paint.

Experiments to be described later have shown that carbolinum and brunolinum have an extremely deleterious action upon scrap rubber and so are unsuitable for daily painting, for which either "formalin-bisulphite" or izal should be used.

For painting at longer intervals brunolinum is to be recommended, because of its greater persistence.

To sum up—

(1) as a general rule, "black-stripe" tissues need not be cut out;

(2) sterilization of tapping knives is unnecessary when preventive painting is carried out.

THE ANÆROBIC COAGULATION OF HEVEA LATEX.

By B. J. Eaton.

THE writer in collaboration with J. Grantham has shown (*Agricultural Bulletin, F.M.S*, Vol. IV, No. 2, November, 1915), that the natural coagulation of Hevea latex under anærobic conditions, is due to the presence of certain micro-organisms which infect the latex after it leaves the tree. We have also shown that coagulation, under these conditions, is not always complete with latices from trees from different areas, but that complete coagulation, under anærobic conditions, can be obtained by the addition of small quantities of various sugars to latex, which enables the particular organism or organisms, which are responsible for such coagulation, to increase at the expense of other (ærobic) organisms which prevent coagulation. Our researches on this problem were continued by Drs. Gorter and Swart in Java (*Vide Bulletin* No. 6, West Java Rubber Testing Station and *Agricultural Bulletin, F.M.S.*, Vol. V, No. 2, November, 1916), who showed that, under these conditions, the chief ultimate product formed in the latex and serum was lactic acid, to which they attributed the coagulating effect produced.

The final proof of the correctness of our theory has now been given by two French scientific officers M. M. Denier and Vernet in a paper entitled "Etude bacteriologique de la coagulation naturelle du latex d' Hevea brasiliensis" published in the *Comptes Rendus des Sciences de l' Academie des Sciences*" No. 3, July, 1917. These workers have now isolated an organism from Hevea latex, which, under anærobic conditions, is capable of effecting coagulation within 24 hours, although in some cases, it was found necessary, as in our work, to add saccharine matter to the latex.

Altogether twenty-six species of ærobic and facultative ærobic organisms and one anærobic organism were isolated from the latex by these workers. These organisms belonged to various species and included cocci, cocco-bacilli and bacilli. The cocci were represented by two varieties. The bacilli are very numerous but a number do not present any particular characteristics while others are chromogenic or have medial or terminal spores. The principal bacterium utilized in the researches had the following characters. A short bacillus with rounded ends, slightly mobile and not stained by Gram's method. On sloped agar cultures, the growth was greyish white, without any special features. It grows vigorously on litmus—latex-serum-agar producing acid and gas. Acid and gas were also produced on litmus agar containing lactose or saccharose; gas formation is particularly marked with saccharose. It also produces acid in and coagulates litmus milk. The organism has no proteolytic action on coagulated egg albumen; on the contrary it liquefies gelatine, giving a cone of liquefaction with production of gas.

In order to obtain perfect coagulation, the authors confirm our previous work as to the precautions necessary to obtain the best results:

"(1) When coagulation is slow, it is useful to add saccharine substances in order to accelerate it. This has been practised for several years at Nha-Trang (Cochin-China) when experiments demonstrate its necessity.

Sugar is added in the proportion of one gramme per litre of latex (=1 in 1000); smaller proportions are, however, usually sufficient.

(2) The surface of the latex coagulated by this method, under ærobic conditions, has an alkaline scum, in which ærobic bacteria exist, preventing coagulation at this level, as shown by Eaton and Grantham.

The addition of sugar, proposed by Eaton and Grantham, impedes the development of these bacteria, but the results are still better if coagulation is effected under anærobic conditions. This can be carried out in a simple manner by using a wooden float on the surface of the latex, which retards the development of these bacteria.

The rubber obtained is at first white but darkens subsequently. In order to prevent this darkening the coagulum can be sterilized by heat or by treating it with a solution of formalin. (*Note.*—The writer prefers soaking the coagulum and the freshly machined rubber in a solution of sodium bisulphite for this purpose.) The same result is stated to be obtained by excluding air for a period of four days.

(3) Zinc vessels to contain the latex must not be used. This is probably explained by the toxic action of zinc salts on the organisms contained in latex. (*Note.*—This was also observed on Cicely Estate, where shallow galvanized iron pans were used for coagulation, in the preparation of sheet rubber. These pans had to be painted with white enamel, owing to the action of the zinc in preventing the coagulation.) The writer attributed this to the neutralization of the lactic acid by the zinc. The explanation given by M. M. Denier and Vernet is, however, probably correct.

The Enzyme Theory.

In the *Jour. Soc. of Chem. Industry*, Vol. XXXVI, No. 5, 15th March, 1917, L. E. Campbell has revived the hypothesis, first postulated by Whitby, to the effect that the natural coagulation of Hevea latex is due to a coagulating enzyme.

As no reference is made to our work on the bacterial theory, it is probable that Campbell had overlooked this paper, especially since no criticism of our theory is given in his paper.

No enzyme, however, was isolated by either Whitby or Campbell and the results obtained by both workers can be explained on the bacterial theory, which has now been proved definitely by the isolation of an organism capable of effecting such coagulation.

Campbell bases his theory of a coagulating enzyme chiefly on the effect of soluble calcium salts in causing coagulation of Hevea latex, comparing the influence of this salt with its influence on the clotting of blood and milk. It is well known, however, that soluble calcium salts and other dibasic and tribasic salts of the metals coagulate Hevea latex and this effect is probably a chemical or physical effect similar to that of the acids, except that rather larger quantities of the salts are required.

On the other hand, if an insoluble salt is produced—*e.g.*, by precipitating the calcium as insoluble calcium oxalate, coagulation is prevented. The addition of salts such as potassium oxalate and sodium fluoride, to inhibit the effect of soluble calcium salts, can also be explained on the bacterial theory since these salts are bactericides. It is also probable that soluble calcium salts have an influence in accelerating the biological changes due to living organisms, in a similar manner to saccharine substances, by favouring the anærobic organism responsible for natural coagulation, at the expense of other organisms which inhibit coagulation. A possible explanation of this is to be found on the assumption that the calcium salts combine with the proteins in the latex, the decomposition of which is known to inhibit coagulation, owing to the formation of alkaline bases.

In view of the results of our researches on the bacterial coagulation of latex, confirmed by Gorter and Swart, who isolated lactic acid from latex produced by this bacterial action and the final isolation of an anærobic organism, capable of effecting natural coagulation, by Denier and Vernet, the coagulating enzyme hypothsis cannot be accepted without further proof.

FIELD EXPERIMENTS WITH RICE.

By G. E. Coombs and D. H. Grist.

The Standardization of the Trial Ground at Kuala Pilah.

IN a previous issue of the *Agricultural Bulletin*[1] is given a short account of the scientific basis which should govern field experimentation. It is shown from the results of the work of previous investigators[2] and by illustration with the results of preliminary experiments on rice and coconuts that

(*a*) the results of single experiments, where two blocks of land carrying a crop, are used in comparison of the effect of altered conditions on either of them are misleading;

(*b*) that the size of the plots used, materially affects the accuracy of the result obtainable (within limits the larger the plot the more accuracy is attainable);

(*c*) that duplication, obtained through averaging the results of plots similarly treated, forms a supplementary method over that of size of plot increase, of increasing the accuracy;

(*d*) that on the basis of data collected from a preliminary survey, where blocks of land carrying the crop are given as far as possible identical treatment, it is possible to calculate the size of plot and the extent of duplication that is necessary to attain results of required precision.

Reference should be made to the original publication[3] for the details of the method and the mathematical argument; here, it is only necessary to state that the workers established the standard that 30: 1 odds would amount to practical certainty. This standard means that the observed differences in yield as the result of different treatments between any two plots of whatever size, must be at least 4-5 times the "Probable Error" of either plot, before the result can be significant as representing the result of the altered treatment.

They showed that for root and cereal crops the "Probable Error" is about five per cent. of the crop, this figure being independent of the size of the plot employed provided this is 1/80 acre or larger.

These facts refer to crops in temperate climates. In the tropics we have entirely different conditions, and though the method of work under these conditions is dictated by the same principles, it is necessary that a preliminary investigation of like nature to the one referred to above be made for annual and for permanent crops. Work is at present in progress in connection with the question of the size of small plots which may be used for breeding experiments—the trial of one pure-line of rice against another. It is also being done for rubber.

The rice crop introduces a number of additional factors to those which obtained in the experiments dealt with by Wood and Stratton.

[1] Coombs and Grantham. *Agricultural Bulletin, F.M.S.*, Vol. IV, No. 7, 1916.
[2] Wood and Stratton. *Journal of Agricultural Science*, Vol. III, 1914.
[3] Loc.-cit.

The regulation of the time of incidence and the varying heights of the water-supply, of aeration and its relation to water movement, of water temperature, etc., are among many peculiar to this crop, and dictate special precautionary measures in framing experiments on the same. At the present moment the field work on this crop in this country is concentrated into two areas (Krian and Kuala Pilah), which will form the breeding-grounds for several subsidiary testing areas. In Krian conditions are much the more uniform. The land lies in a large open tract where large areas of uniform soil may be found and is fed by a regulated water-supply from an irrigation system. The uniform preparation of the soil can be easily controlled and depredations due to pests are of less consequence. Kuala Pilah furnishes conditions typical of practically all the padi-land of the country lying outside the irrigation area. The land itself is divided into small divisions called "lopaks" separated from one another by bunds (batas) through which the water-supply—the rainfall from the hills—is fed. The "lopaks" themselves are often in definite terrace formation—a formation which has been evolved by the natives to ensure the maximum benefit from the precarious water-supply. Conditions appear to be so radically different from those of the irrigation area that it appeared necessary to standardize this type of land with its prevailing set of conditions. This was done as follows:

A piece of land (sawah) rather over two acres in extent and fairly uniform in texture but possessing "lopaks" of uneven size, was measured into plots of 1/200 acre each. These plots were so arranged that though the limits of the plots in any "lopak" might adjoin, no plot was continued to the batas. The plots were 200 in number. Every care was taken to ensure uniformity in the preparation of the ground which was planted up without regard to the limits of the plots with seedlings of a pure-line of Padi Lebat raised in a wet nursery for forty days, and planted out at a rate of one seedling per hole one foot apart each way.

An inspection of the standing crop prior to harvest showed that the contents of the "lopaks" receiving the direct water-supply tillered more freely, matured more quickly and as was afterwards ascertained gave larger yields than did those of the plots further removed from the same. This may possibly be ascribed to the freer aeration[1] and temperature effect consequent on the greater movement of the water. It would always be advisable in experimenting on land of this nature to exclude the plots immediately near the water-supply.

Harvest was performed by the native instrument—the "tuai"—and the padi threshed dried, cleaned and weighed.

The data obtained is given in condensed form in the curve appended and analysed for the estimation of the "Probable Error" of single 1/200 acre plots from the formula:

$$\text{P. E.} = .67\sqrt{\frac{\Sigma d^2}{N-1}}$$

The plots were then combined in contiguous pairs and in contiguous groups of fours, and eights, with the results disclosed in column 1 of table 1, percentages being calculated on the respective mean yields for the different sized groupings.

[1] Harrison and Ayer. *Agricultural Journal of India*, Vol. IV, No. 1.

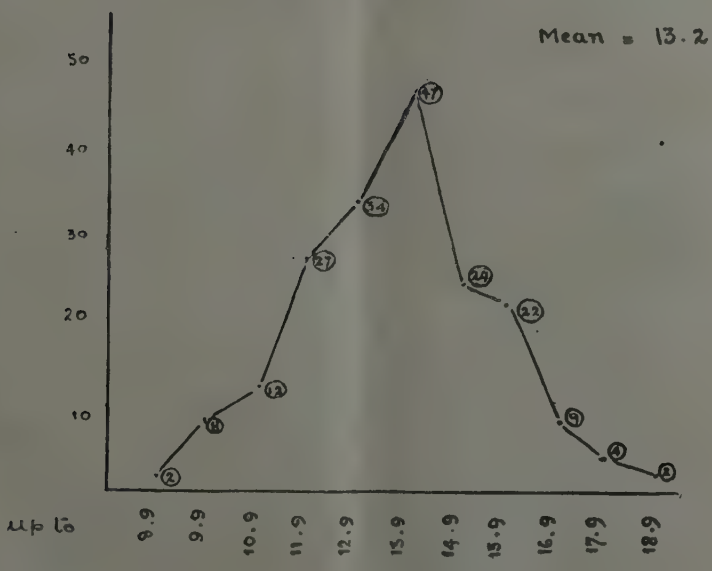
This massing of plot area is, however, to be distinguished from the indiscriminate selection of plots for average results which process is known as duplication. The extent of additional accuracy obtained by the respective duplication of plots of different sizes is shown in column 2 of the table. It will be noticed that 1/25 acre represents the limit of the size of the single plots used, and it is not known whether plots of larger magnitude would have still further reduced the error or no but this is not important from the point of view of this work which was devised merely as a means of standardizing the area for variety and line testing and for manurial trials.

TABLE I.

Size of Plot.	ERROR. Single Plot.	Duplicate.
1/200 acre	± 9.9 per cent.	± 7.1 per cent.
1/100 „	± 8.0 „	± 5.7 „
1/50 „	± 6.1 „	± 4.3 „
1/25 „	± 5.5 „	± 3.8 „

TABLE II.

Frequency curve of yields from 200 plots each of 1/200 acre.



SUMMARY OF LOCUST WORK FOR THE 2nd QUARTER, 1917.

By F. W. South.

DURING this quarter the prospect of completely finishing the locust work this year further improved. There were no locusts in the Federated Malay States and in Malacca the season of destruction work commenced in March was concluded on 4th May when there were no more locusts to be found in the Territory. Careful search in all remote lalang patches failed to reveal any swarms so that at the close of the quarter the Territory was still free from locusts; this result is very satisfactory and reflects great credit on Mr. Lyford who completely freed Malacca of locusts in 13 months. It is, of course, possible that one or two swarms may come in from Johore now that the south-west monsoon has set in, but there have been only some ten swarms in Johore during the quarter of which five are very small and may never reproduce themselves, while the remainder are not large. Seven of the Johore swarms are in the Tangkak district so possibly one or two small swarms may lay eggs in the Southern district of Malacca during the coming quarter, but even so the resulting hoppers should be easily destroyed.

The prevailing very wet weather during the half year has assisted in the destruction of the locusts to almost the same extent as the favourable conditions which obtained for the greater part of 1916 hindered it, but at the same time there can be no doubt that the swarms would have been far more numerous had it not been for the large amount of destruction work carried out during last year.

Staff Changes.

The absence of locusts from the Federated Malay States made it possible to reduce the total staff by the end of the quarter to four conductors and mandors. These four men were placed as scouts along the Negri Sembilan-Malacca boundary in case any swarms make their way in along the railway line from Johore or escape the notice of the Malacca scouts and enter from the Territory. A further change has been recommended, namely to place all the work in Johore, Malacca and on the Negri Sembilan boundary in charge of Mr. Lyford thus centralizing the control over the comparatively small infested area and freeing the Assistant Agricultural Inspectors in the Negri Sembilan and Johore for very necessary inspection work on estates and small holdings.

The Federated Malay States.

Beyond the absence of any known swarms of locusts and the staff changes already referred to, there is nothing to report.

Malacca.

The destruction of the swarms of hoppers present around Durian Tunggul near the roads to Machap and to Alor Gajah was continued throughout the month of April until the 23rd when the work was

completed. Work was carried out near the 11th and 12th miles, Parit Melana, the 14th mile, Malaka Pindah, and the 10½ mile, Durian Tunggul. The eggs laid by the large swarm of fliers on Jasin Lalang Estate at the end of March hatched out and work commenced there on 3rd April and all these hoppers were destroyed by the 24th. A further small swarms of fliers arrived on the estate and laid eggs on 7th April. These eggs hatched out on the 25th. Many of the hoppers were eaten by birds and the remainder were stamped out or beaten out by the coolies. No sheeting was used for these. The work was finally concluded on 4th May. In all 216 gangs comprising 2,461 coolies were employed during this period. The maximum number of gangs at work on any one day was nine and the average number of gangs per day was between seven and eight. At the end of April there were no flying swarms present in the Territory.

During April and the subsequent months until 28th June all likely breeding grounds and all remote lalang patches were systematically searched for locusts but none were found. It is, therefore, concluded that Malacca is free from locusts, though now that the South-west monsoon has set in, one or two swarms may come in from around Tangkak in Johore.

Johore.

There were from 8 to 15 flying swarms present during the quarter of which most were in the Tangkak and the Muar districts. Eggs laid at Jorak in the previous quarter did not hatch out nor did eggs laid at Jementah in May. Eggs were laid and hoppers hatched out on both banks of the Muar river in May between Belamang and Tanjong Olah on the right bank and from Bukit Durian through Jorak to Pengkalen Bukit on the opposite bank. Destruction work was carried on successfully for the greater part of June and was concluded at the end of the month; in all 134 swarms were poisoned. The number of flying swarms remaining at the end of the quarter was somewhat uncertain, though eight, mostly small, were under observation.

Tangkak.—In April the three swarms present in March still remained in this district, one at Relau near Bekok, one at Sagil Dalam and one at Bukit 140. On 3rd April, another swarm came from Jasin and settled near Sebrang Gajah just over one mile from the Malacca boundary. During May the number of flying swarms was increased to eight, as four more swarms appeared in districts where there are no Malays so that the direction from which they came was not noticed. The distribution of these swarms was: around Bekok three, one at Bekok, one at Relau, and one at Bukit 140; one at Ayer Panas of medium size; one each at Sagil, Sagil Dalam, Sebrang Gajah and Kabun Bahru, all small. It was thought that some of these swarms had already laid eggs, but that owing to the heavy rains most of the favourite breeding grounds had been flooded at various times so that the eggs failed to hatch.

In June there was one small swarm at Sagil Dalam and one at Batu 12 with a very small swarm in each of the other places Sagil Luar, Bekok, Ayer Panas, Sebrang Gajah and Kabun Bahru, all these locusts put together would not amount to a large swarm. There were no eggs or hoppers during the quarter and it would seem

that these scattered small swarms are dying out without reproducing themselves much as did the few remaining in Selangor during last year.

Sungei Mati.—This district remained free from locusts, as in March, until 18th April when a swarm arrived at Bukit Tampoi close to Tangkak and divided on 23rd April, part going to Serom and part to Lanchang. At the end of the month the Serom portion flew up the river and that from Lanchang went towards Tangkak, leaving the district free again. In May the Serom portion returned to Belamang about the middle of the month and laid eggs there. The eggs hatched out on 27th May and after a few days spent in collecting coolies, work was commenced on 1st June. The hoppers were all destroyed by 25th June. The gang had to work at several places from Belamang to Serom, Sungei Ubi and as far up as Tanjong Olak Estate. At first coolies were difficult to obtain as only a few of the old gang would work, but after a few days the Penghulu obtained a sufficient number of Javanese. A certain amount of damage was done to padi in the kampongs at Belamang. At the end of the month the district was free from locusts.

Batu Anam district.—In April only one mandor was working in this district as the other was ill. The only swarm known was that reported at Paloh in March. This was reported at Nior on the 16th and went to Kluang on the 18th where it did some damage to coconut palms. It left the Kluang district on 7th May and travelled north. A little later, a swarm appeared near Jementah from the Kluang direction so that it seemed certain that this was the Kluang swarm. On the 28th this swarm laid eggs near the road from Jementah to Kebun Bahru about four miles from Jementah. Up to the end of June these eggs had not hatched out so that probably they will not give rise to hoppers.

About the middle of May a new swarm of fliers arrived at Gemas from Ayer Kuning. They stayed at Gemas four days and then went to the old breeding ground at Spening near Buloh Kasap. In June this swarm disappeared and had not been heard of again up to the end of the quarter. The two mandors made a thorough inspection of the district during June from Kluang to Gemas on the railway, up to Ulu Palong, down the Muar river to Tebing Tinggi and from Jementah to Kebun Bahru. Only one small swarm was found at Tebing Tinggi, no other locusts were reported from the Batu Anam district.

Muar district.—In April four swarms were known in this district, the largest of which was at Ulu Sarang Buaya, about five miles beyond the end of the Muar Railway. There was a swarm at Kangkak Jorak which was probably from the Sungei Mati district. Another swarm which arrived at Bandar Maharani on the 5th proceeded after two days to Parit Pechah, about eight miles up the railway line. The fourth, a small swarm was reported at Bukit Dinding near the end of the Jalan Bakri. The eggs at the laying ground near Jorak reported in March did not hatch and no hoppers were found.

In May the Kangkak Jorak swarm laid eggs at Bukit Durian, three miles from Bukit Pasir along the new road. Hoppers appeared

there on the 27th and after some difficulty in getting coolies destruction work was started on 2nd June. The gang gradually moved round from Bukit Durian by way of Jorak to various districts, finally finishing up at Pengkalen Bukit at the end of the month. Coolies were again difficult to obtain and three quarters of the gang had to be brought from Tangkak and Bekok.

In May the swarm at Ulu Sarang Buaya remained there. It was composed of a mixture of young and old fliers of which the older insects had laid eggs that came to nothing.

The swarm at Parit Pechah disappeared and the Malays said it had simply died off.

The small swarm at Bukit Dinding was coupling.

In June the mandor was busy supervising the destruction work far from the districts from which the other swarms were reported so that nothing very certain is known of the number of flying swarms which is, however, probably small. There was a doubtful report of a swarm visiting Batu Pahat in May, but this cannot be investigated until the road is passable.

Panchor district.—One swarm was seen in the district in April, it arrived at Panchor from the direction of Sungei Raya on the 13th. It then flew to the Pengkalen Bukit district and finally went to Jorak. It was probably the same as that mentioned in the Sungei Mati and Muar reports since Jorak is the boundary of all three districts and the swarm was probably seen by all three mandors. There were no locusts in this district in May or June.

Conclusion.

At present the few remaining swarms in the Peninsula are mainly concentrated in the Tangkak neighbourhood in Johore with possibly two swarms in the Muar district and one or two more moving about along the river or around Batu Anam. None of the swarms are large and as some of them are now old, it is possible that a considerable portion of the locusts will die out without laying eggs.

The position is so satisfactory that it encourages the hope that the locusts may have been successfully exterminated by the end of the year, though this will depend somewhat on weather conditions and on the success attending the search for the few remaining scattered swarms in the difficult country of northern Johore.

Table of Results, 2nd Quarter, 1917.

State.	District.	Locality.	Date.	Swarms Driven.	Tins.	Swarms Poisoned.	Total Swarms.	State Totals.
Malacca ...	Northern ...	Durian Tunggul, 10½ mile ...	1st to 23rd April					
		Parit Melana, 11th and 12th miles						
		Malaka Pindah, 14th mile ...		415	...	...	415	
	Southern	Jasin Lalang ...	3rd April to 4th May ...	...	...	...	...	415
			Total ...	415	...	...	415	415
Johore ...	Sungei Mati ...	Belamang ...	1st to 25th June ...	...	...	46	46	
	Muar	Around Jorak ...	2nd to 30th June ...	...	...	88	88	134
			Total ...	...	...	134	134	134
			Grand Total ...	...	...	...	...	549

Table of Results, 1st Half Year, 1917.

State.	District.	Locality.	Date.	Swarms Driven.	Tins.	Swarms Poisoned.	Total Swarms.	State Totals.
Negri Sembilan ...	Tampin	Ayer Kuning ...	1st January to 4th February	...	...	33	33	
		Batang Malaka		...	...	172	172	
		Gemencheh		...	...	9	9	
		Gemencheh		...	...	73	73	
		Pondoi		...	...	13	13	
		Bukit Putus		...	..	8	8	
	Kuala Pilah ...	Selaru		2	...	37	39	
		Lunding and Johol						
			Total ...	2	...	345	347	347
Malacca ...	Southern ...	Diamond Jubilee Estate	1st January to 8th February	298	...	...	298	
		Batang Malaka						
		Chabau						
		Rim						
	Northern ...	Keru						
		Tebong						
		Machap						
		Tebolang Estate						
Malacca ...	Northern	Kuala Linggi ...	20th to 24th February ...	17	...	...	17	
Malacca ...	Northern ...	Parit Melana, 11th and 12th miles, Alor Gajah Road and 11th mile, Machap Road	19th March to 4th May	484	...	...	484	
		Malaka Pindah, 14th mile						
		Durian Tunggul, 10½ mile						
	Southern	Jasin Lalang						
			Total ...	799	...	..	799	799

Table of Results, 1st Half Year, 1917.

State.	District.	Locality.	Date.	Swarms Driven.	Tins.	Swarms Poisoned.	Total Swarms.	State Totals.	Remarks.
Johore ...	Tangkak ...	...	1st to 31st January	136	184	72	208		
	Panchor ...	Near Bukit Kepong ...	...	...	...	...	...	...	Eggs were drowned by floods.
	Batu Anam ...	Bekok	...	...	...	32	32		
	Tangkak ...	Bekok	...	...	...	...	...	...	Eggs drowned by rain.
Johore ...	Sungei Mati ...	Tanjong Bungsal	1st to 31st March	...	...	...	...	...	The flying insects died in large numbers owing to wet weather.
		Merbau Berdarah							
		Glogoh		...	...	...	...	...	Eggs were laid about 10th March, but were drowned by heavy rains.
		Telok Remba							
Johore ...	Sungei Mati ...	Belamang	1st to 30th June	...	...	46	46		
	Muar	Around Jorak		...	...	88	88		
			Total ...	136	184	238	374	374	
			Grand Total ...	...	...	...	...	1,520	

MINUTES OF A MEETING OF THE ADVISORY COMMITTEE, DEPARTMENT OF AGRICULTURE,

HELD AT THE OFFICES OF THE DEPARTMENT, KUALA LUMPUR, ON 31ST OCTOBER, 1917, AT 11 A.M.

Present:—Mr. L. Lewton-Brain, Director of Agriculture (Chairman), the Hon'ble Mr. R. C. M. Kindersley, Messrs. H. Armstrong, C. Bell, W. de L. Brooke, W. S. Cookson, J. S. Ferguson, J. D. McCulloch, L. Mooijaart and C. Ritchie.

Absent:—Messrs. W. Dell, T. W. Hodge, A. B. Milne, R. W. Munro and H. R. Quartley.

Messrs. F. W. South, G. E. Coombs and W. N. C. Belgrave attend the meeting.

Mr. B. Bunting, Assistant Agriculturist, officiates as Hon. Secretary to the meeting.

1.—MINUTES.

The minutes of the previous meeting held on 26th July, 1917, having been circulated were taken as read and confirmed.

The CHAIRMAN informs the Committee that Government had granted permission to publish an abstract of the minutes of the Advisory Committee meetings both in the *Agricultural Bulletin* and in the local press, providing that such abstracts be submitted to Government for approval previous to publication.

2.—EXPERIMENTAL COCONUT PLANTATION.

The CHAIRMAN reports that since the last meeting Government had taken over Sipantas Estate and considerable progress had been made on cleaning up under the supervision of Mr. J. Lambourne, who is in charge of the work in addition to his duties on Castleton Estate, Telok Anson. Mr. R. W. Munro had been appointed to make a monthly visit and advise on the working of the estate. It is pointed out that until the estate is thoroughly cleaned up it would be impossible to start any experimental work and it is unanimously agreed that no experiments be started until the sub-committee had met and made their suggestions.

3.—AGRICULTURAL CONFERENCE.

The CHAIRMAN draws attention to the fact that so far he had received only about six names for the General Conference Committee and that as things stood at present it was impossible to do anything in the matter. He thought it would be impossible to complete arrangements for holding the conference much before September and that he hoped that official invitations would be sent to representatives from other countries and colonies.

After some discussion it is proposed by Mr. Kindersley and seconded by Mr. McCulloch that this Committee recommends that the forthcoming Agricultural Conference be held at as early a date as possible and that it should not be later than September.

4.—PESTS AND DISEASES.

The CHAIRMAN informs the Committee that with regard to the suggestion for the prohibition of importation of seed or plants of

Hevea from British Guiana the Chief Secretary had approved that no importation should be allowed except with the permission of the Director of Agriculture and that such notification had already been published in the Federated Malay States *Gazette*. It is not expected that any seed will be imported but if so it will be kept in strict quarantine to ensure that there will be no risk of the infection being introduced into this country.

The CHIEF SECRETARY had also agreed to make a rule that Black-stripe and Mouldy rot shall be made notifiable under the Agricultural Pests Enactment.

The CHAIRMAN points out that with regard to the training of sub-Inspectors a scheme has been approved and would come into force on 1st January, 1918. Under this scheme four Malays were being sent to Kuala Kangsar College in 1918 and would remain there for three years after which they would be required to pass further examinations before being taken on as probationers at the Agricultural Department.

After some discussion a resolution is passed that this Committee is strongly of the opinion that the immediate training of more Malays as additional sub-Inspectors similar to those already employed is very essential and that five new appointments should be made as soon as possible.

Mr. South informs the Committee that it would take about two years to train a sub-Inspector thoroughly.

5.—ESTATE INSPECTION.

The CHAIRMAN describes the work of the inspection department pointing out that it is only possible at present for the Assistant Inspectors to visit estates at the request of managers and that with the present staff it is absolutely impossible for all estates to be inspected as a matter of routine.

It is considered that an estate should be visited at least once during every year and this would necessitate an increase in the inspecting staff as one man could not be expected to visit more than 30 estates during each quarter, which would allow very little time for the inspection of native holdings.

After considerable discussion the matter is referred to the sub-committee for pests and diseases.

6.—EXPERIMENTAL FARMS.

The question of the establishment of experimental farms was again brought before the Committee and after some discussion it is agreed that it would be preferable to have the matter dealt with by the sub-committee for experiments.

7.—GENERAL.

The CHAIRMAN reports that Government had decided to take steps for carrying out experimental work on rubber seed selection as soon as men were available.

The CHAIRMAN informs the Committee that there had been a suggestion made that planters from Johore should attend meetings of the Advisory Committee and that three representatives had now been appointed, one each for North, South and Central Johore.

The meeting terminates at 1.30 p.m.

INDIAN IMMIGRATION COMMITTEE.

A MEETING of the Indian Immigration Committee was held at Penang, on 30th October, 1917.

There were present: The Controller of Labour (Mr. J. R. O. Aldworth), Chairman, the Principal Medical Officer, F.M.S. (Dr. C. L. Sansom, C.M.G.), Mr. F. G. Harvey, Hon'ble Mr. J. Mitchell, Mr. E. E. Smith with the Secretary, Mr. E. W. F. Gilman, Deputy Controller of Labour, Penang.

The following statements of arrivals and departures of Southern Indians for the period 1st January to end of October, 1917, and for the corresponding periods in the five preceding years, were laid before the Committee:

* ARRIVALS.

	State-aided.		Ordinary.	
Year.	Adults.	Minors.	Adults.	Minors.
1912 ...	67,153	5,611	21,800	1,330
1913 ...	77,587	6,933	22,697	1,425
1914 ...	34,247	2,658	13,562	750
1915 ...	46,456	3,265	16,910	995
1916 ...	57,933	6,318	16,477	1,333
1917 ...	64,685	5,713	8,895	724

* To end of October.

* DEPARTURES.

Year.	Adults.	Minors.
1912	47,831	2,057
1913	52,580	2,709
1914	50,513	2,270
1915	40,430	1,844
1916	41,035	1,595
1917	43,762	1,693

* To end of September.

Figures were given showing the satisfactory increase during the past three years in arrivals of independent labourers not recruited by kanganies—viz:

1915	2,069	113
1916	3,098	232
1917	6,097	340

Attention was also drawn to a considerable improvement in arrivals for Malacca which have increased as follows:

1915	2,042 ...	66
1916	3,159 ...	205
1917	4,889 ...	291

A return was presented showing that the number of kangani licences registered in Penang from 1st January to 30th September was 9,203 as compared with 9,081 registered during the whole of 1916. There had also been a great improvement in the proportion of licences presented for registration in India. Out of 5,857 fresh licences issued to Penang in the half year ending 30th June, 5,723 had been registered at the Indian offices.

During the first nine months of the year, 97 licences were refused registration in Penang and 235 were cancelled in consequence of reports received from the Emigration Agents in India, as compared with 108 and 323, respectively, during the whole of 1916.

Mr. Harvey mentioned the inconvenience caused to employers now that kanganies have to present licences for registration in person, in that they do not know the registered numbers of licences. It was decided that in future a postcard should be sent from the Penang office notifying to each employer the registered number of each licence registered.

The Chairman made a statement regarding the outbreak of cholera at the Madras Depôt which started on 12th July, owing to which shipping from that port was suspended and was not resumed till 15th September.

The Committee approved of the payment from the fund of expenses amounting to Rs. 1,550-7-4 incurred in returning to their villages labourers whose embarkation was prevented by this restriction.

Various correspondence connected with recruiting matters was considered and the Chairman drew the attention of employers to the grave harm done to emigration to this country by the operations of Agents, both European and Indian, who have been appointed to supervise the recruiting of certain estates and have been no more nor less than professional recruiters. Employers were warned against employing this class of person.

A statement of quarantine expenses was submitted and considered showing that the average cost per head at each station for the last two quarters was as follows:

	2nd quarter.	3rd quarter.
Penang	$2.11 ...	$2.15
Port Swettenham... ...	1.63 ...	1.63
General average	1.82 ...	1.82

Audited accounts for the half year ending 30th September were laid on the table and passed after consideration. Arrears of assessment were considered and items amounting to $503.42 were written off as irrecoverable.

It was decided, subject to the consent of His Excellency the High Commissioner, to prescribe for the 1st and 2nd quarters of 1918 a quarterly rate of $2 to be paid by every employer in respect of every Indian labourer employed or working on the place of employment during the respective quarters. Similar rates were prescribed for the Straits Settlements, Johore, Kelantan, Kedah and Perlis. The number of working days prescribed in a quarter for the purpose of calculating this assessment was again fixed at 78 for the next two quarters.

It was decided to pay a recruiting allowance of $5 on account of all labourers recruited by licensed kanganies introduced during the 1st and 2nd quarters of 1918.

The appointment of legal advisers to the Committee, for which sanction had been obtained by an amendment to the law, was approved.

On the proposal of Mr. Harvey, seconded by Mr. Smith, a resolution was passed that steps should be taken to advocate the amendment of section 66 (i) of the Labour Code so that a fee of one dollar should be payable in respect of every labourer locally engaged, instead of as at present for each statement of labourers so engaged.

The Chairman undertook to forward the resolution to Government.

In reply to a question, of which the Hon'ble Mr. Mitchell had given notice, the Principal Medical Officer made a statement with regard to the unusual number of deaths that had occurred in the Port Swettenham Quarantine Station in 1916, and described the steps that were being taken to investigate and combat the spread of pneumonia which had been responsible for the largest number of these deaths.

The report on the Home for Decrepit Indians for the year ending 31st October was submitted. During the year 190 decrepits were admitted, 82 were repatriated, 35 were transferred to the General or District Hospital, 38 absconded from Hospitals or the Home. The number of inmates remaining on 27th October was 52. A sum of $7,399.96 had been expended. An expenditure of $9,000 was approved for the twelve months beginning on the 1st November, 1917.

The sub-committee appointed to consider the tenders for the feeding contract for the Port Swettenham Quarantine Station for 1918 presented their report.

In consequence of a serious accident which occurred in the month of June last, during the removal of a number of immigrants from the Port Swettenham Depôt to an estate, it was resolved to issue the following circular to employers:

In future immigrants will only be delivered from the depôt under the following conditions:

(*a*) Except under special circumstances, of which the officer in charge of the depôt shall be the judge, immigrants shall only be removed from the depôt between 6 a.m. and 3 p.m. and arrangements shall be made by the employer to avoid all unnecessary travelling by night.

(*b*) Arrangements shall be made by the employer for all parties of ten or more immigrants to be accompanied on all parts of their journey which are to be performed on foot by a responsible headman, kangany, mandor, watchmen or person of similar station. No person shall perform these duties if considered unfit to do so by the officer in charge of the depôt.

(*c*) Arrangements shall be made by the employer of all parties of thirty or more immigrants to be taken delivery of at the depôt by an English speaking clerk, conductor or overseer authorized to supervise the removal and transport of such immigrants to their place of employment.

The officer in charge of the depôt is authorized to refuse delivery of immigrants to any employer who does not satisfy him that the arrangements made for the transport of the labourers are sufficient to ensure their journey being performed under proper supervision.

OBITUARY.

We record with deep regret the death of Lieut. Frederick Goatcher, 9th Batt. Suffolk Regiment, Assistant Agricultural Inspector, Johore, who died of wounds received in action on the Western Front on the 31st October, 1917.

TABLE I.

Agricultural Acreages, Straits Settlements, 1915 and 1916, excluding Padi and Horticulture from Estates over 100 acres in extent.

—	Province Wellesley.		Dindings.		Singapore.		Penang.		Malacca.		Total.	
	1915.	1916.	1915.	1916.	1915.	1916.	1915.	1916.	1915.	1916.	1915.	1916.
Coconuts	16,617	16,380	3,209	3,292	569	980	2,537	2,096	181	216	23,113	22,964
Rubber	26,925	28,369	3,585	5,191	21,306	23,504	4,440	6,242	73,278	81,833	129,534	145,139
Coffee	...	...	...	...	130	160	...	...	...	...	130	160
Other cultivations...	90	24	570	...	208	170	267	10	1,537	...	2,672	204
Total ...	43,632	44,773	7,364	8,483	22,213	24,814	7,244	8,348	74,996	82,049	155,449	168,467

TABLE II.

Agricultural Acreages, Straits Settlements, 1916, from Estates over 100 acres in extent.

	Province Wellesley.	Dindings.	Singapore.	Penang.	Malacca.	Grand Total.
Rubber alone	28,131	5,191	20,583	6,122	81,557	141,584
,, and Coffee						
,, and Coconuts	187	...	68	50	51	356
,, with other crops...	51	...	2,853	70	225	3,199
Total ...	28,369	5,191	23,504	6,242	81,833	145,139
Coconuts alone	16,181	3,092	253	2,001	125	21,652
,, and Coffee	...	...	160	...	...	160
,, with other crops	199	200	567	95	91	1,152
Total ...	16,380	3,292	980	2,096	216	22,964
Coffee alone						
,, with other crops	...	160	...	...	...	160
Total ...	...	160	...	...	...	160

TABLE. III.

Rubber Statistics, Straits Settlements, up to 31st December, 1915 and 1916 from Estates over 100 acres in extent.

	Province Wellesley.		Dindings.		Singapore.		Penang.		Malacca.		Total.	
	1915.	1916.	1915.	1916.	1915.	1916.	1915.	1916.	1915.	1916.	1915.	1916.
No. of Estates ...	47	49	8	13	36	40	22	21	90	89	203	212
Acreage in possession	71,985	73,388	14,042	16,179	28,727	31,271	11,343	12,642	104,610	114,089	230,707	247,569
Acreage planted up to 31st December, 1915 and 1916	26,925	28,369	3,585	5,191	21,306	23,504	4,440	6,242	73,278	81,833	129,534	145,139
Rubber alone... ...	26,797	28,131	3,585	5,191	17,940	20,583	4,288	6,122	72,436	81,557	125,046	141,584
Rubber interplanted with catch-crops ...	128	238	...	...	3,366	2,921	152	120	842	276	4,488	3,555
Acreage producing ...	15,897	18,977	1,389	3,678	7,719	10,905	811	5,486	40,327	49,390	66,143	88,436

Table IV.

Comparative Table of Rubber Crops, Straits Settlements, 1907 to 1916.

State.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.
	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.	Tons Cwt.
Malacca	10 10	23 13	16 9	267 16	382 11	1,742 6	3,549 2	3,979 16	5,181 1	6,606 12
Province Wellesley *... ...	36 13	41 7	131 1	198 19	571 15	1,973 16	2,498 12	3,076 8	3,177 11	3,912 11

* Including Singapore, Penang and Dindings.

TABLE V.

Estate Labour, Straits Settlements, 1916, from Estates over 100 acres in extent.

Race.	Province Wellesley.	Dindings.	Singapore.	Penang.	Malacca.	Total.
Tamil Men	5,789	1,491	1,026	565	6,937	15,808
„ Women	2,474	557	90	153	1,282	4,556
„ Children	350	187	20	51	700	1,308
Javanese Men	839	...	1,159	...	451	2,449
„ Women	558	...	87	...	72	717
Malays	1,616	113	170	201	4,179	6,279
Chinese	665	416	3,359	135	8,408	12,983
Others	1,577	30	207	4	201	2,019
Labour Total ...	13,868	2,794	6,118	1,109	22,230	46,119

Abstract of Meteorological Readings in the various Districts of Malaya for the month of July, 1917.

District.	Mean Barometrical Pressure at 32° Fah.	Maximum in Sun.	Temperature.				Hygrometer.				Prevailing Direction of Winds.	Total Rainfall.	Greatest Rainfall during 24 hours.
			Mean Dry Bulb.	Maximum.	Minimum.	Range.	Mean Wet Bulb.	Vapour Tension.	Dew Point.	Humidity.			
Kelantan, Kota Bahru	...	141.0	82.3	90.64	75.06	15.35	76.0	.779	71.8	70.0	...	9.61	2.88
Pahang, Kuala Lipis	...	...	80.61	89.25	72.8	16.45	76.69	...	...	...	...	4.24	1.41
Johore, Johore Bahru	...	...	...	87.0	73.56	13.44	...	...	...	...	...	3.84	
Singapore, Kandang Kerbau ...	29.769	159.0	83.2	88.0	74.9	13.1	78.06	.884	...	78.3	...	2.18	0.59
Malacca, Durian Daun ...	29.798	148.1	82.9	88.2	72.3	15.9	79.3	.952	...	80.6	S.E.	7.95	1.49
Negri Sembilan, Seremban ...	...	154.0	81.5	87.7	71.3	16.4	75.8	.826	73.5	81.9	N.W.	5.69	1.73
„ Kuala Pilah ...	...	141.6	81.3	89.9	72.6	17.3	78.7	.938	77.0	87.0	...	2.73	1.22
„ Port Dickson...	...	152.8	81.5	87.1	74.0	13.1	77.3	.838	74.4	79.6	...	9.44	2.94
Selangor, Kuala Lumpur ...	29.753	137.7	83.0	88.4	74.0	14.4	76.5	.831	73.5	79.0	N.W.	5.79	1.33
„ Klang	...	...	80.6	85.4	72.7	12.7	76.4	...	...	...	...	4.08	1.12
„ Kuala Selangor ...	...	...	...	88.7	75.4	13.7	...	...	...	...	...	3.16	2.16
„ Rawang	...	...	...	92.7	...	...	...	...	...	...	...	2.79	1.07
Perak, Telok Anson	...	...	83.25	92.0	70.0	22.0	78.91	.930	...	83.0	...	3.54	0.94
„ Ipoh	...	...	82.48	94.0	71.0	23.0	76.61	.840	74.03	77.0	...	5.31	1.53
„ Taiping	...	113.0	80.33	94.0	71.0	23.0	76.72	.872	...	85.0	...	13.18	4.13
„ The Cottage	...	...	...	...	...	...	...	...	...	...	...	26.96	8.46
„ Parit Buntar	...	...	83.47	94.0	71.0	23.0	78.16	.893	...	79.0	...	5.70	2.91
Penang, Georgetown	29.744	139.6	80.1	89.0	75.6	13.4	76.5	.850	72.0	78.0	E.	8.64	3.07
Kedah, Alor Star	...	...	...	...	...	...	...	...	...	...	...	12.77	3.51
Perlis, Kangar	...	...	...	87.09	74.12	12.97	...	...	...	...	...	13.51	2.57